A shortage of suitable DMU stock means operators on many regional and suburban routes in Britain are struggling to cope with an inadequate fleet of ageing trains. One solution could be the conversion of former London Underground trains to DMUs, as Keith Barrow discovers.

Hidden from view in a workshop at the former Long Marston army base in central England, a remarkable transformation is taking place which could help to address one of the most pressing issues facing Britain's passenger operators. Rapidly increasing ridership, government hesitancy and changes in traction policy have led to a chronic shortage of DMUs.

Much of the existing DMU fleet is nearly 30 years old and all vehicles remaining in service beyond 2020 will need to comply with Rail Vehicle Accessibility (Non-Interoperable Rail System) Regulations 2010 (RVAR). This means vehicle owners will need to decide within the next few years whether to carry out potentially costly modifications on fleets with a limited lifespan.

The economics of replacement with new vehicles could also be shaky. New trains inevitably mean higher lease charges, a key consideration with increasing pressure to reduce revenue support for regional franchises. Leasing companies may be unwilling to invest significant sums in assets with a 30-year design life which could be made redundant by electrification in less than half that time. Furthermore, the limited loading gauge makes Britain a specialist market, and with relatively small potential orders, competition between suppliers is likely to be limited, with implications for unit prices.

All this creates fertile ground for innovation in the rolling stock business, and one proposal in particular has provoked a huge level of interest. In 2012 a group of railway engineers led by former Chiltern Railways chairman Mr Adrian Shooter with the backing of Railroad Development Corporation, United States set up Vivarail with the aim of converting redundant London Underground trains into DMUs for use on the mainline network.

Last October Vivarail successfully bid for a significant number of D78 cars rendered surplus by the introduction of new Bombardier trains on the District Line. The trains were originally supplied by Metro-Cammell (later part of Alstom) between 1980 and 1983 and the fleet was refurbished and equipped with new flexible frame bogies as recently as 2005.

Vivarail says it has acquired 150 driving motor cars and enough intermediate trailers to form 75 trains. Two, three and four-car sets will be offered in three different variants with two or four sets of doors per vehicle. The trains will be available to purchase or lease through a leasing partner, which Vivarail says has "considerable experience of the British market."

With the vehicles in its possession and design work complete, Vivarail has wasted no time in converting the first D-Train and the demonstrator set is on course for completion within the next few months. The prototype train will initially be demonstrated on the 4km circular test track at Long Marston and Vivarail will seek feedback from train operators, passenger groups and staff at this stage to refine the design. Authorisation for operation on the national network is anticipated by September.

The conversion is extensive, and the only major components of the D78 to be
retained in the D-Train will be the aluminium bodyshell, bogies, traction motors and rheostatic braking system.

Each driving motor vehicle will be equipped with an engine raft housing two 3.2 litre five-cylinder Ford diesel engines, each with a nominal output of 149kW, or 596kW for a two or three-car set. This compares with 336kW at 2100rpm for a two-car class 142 Pacer DMU, 416kW for a two-car class 150 Sprinter and 629kW for a three-car class 150, although the class 150 has a heavier steel bodyshell.

The engine selected for the D-Train has been in production since 2006 and is widely used in the automotive industry with applications including the Ford Transit van. Vivarail says the engine is fuel-efficient and offers high performance for rapid acceleration, with the traction configuration providing enough redundancy to ensure that a train can continue running even if one raft fails. Vivarail also says that using multiple diesel engines with stop-start technology will also provide a further reduction in fuel use, and therefore exhaust emissions.

Design and production of the engine rafts has been subcontracted to Revolve Technologies, Britain, which has demonstrated that the traction package is compliant with EU Stage IIIIB emissions standards.

In addition to the power units the engine raft will also accommodate the cooler group, generator, and batteries.

The D-Train retains the existing Brush traction motors, but Vivarail has opted to replace the camshaft control equipment with a solid-state dc chopper system, which is being supplied by Strukton Rail. “We wanted to keep the existing, very robust, traction motors, but with modern control equipment, combined with volume-produced diesel engines,” says Mr Allan Dare, marketing director for Vivarail. “The overall package we have chosen gives us considerable space, weight and maintenance savings compared with the existing camshaft controllers.”

Strukton says the electrical configuration could support the future addition of a battery or supercapacitor-based energy storage system, which would allow power from the regenerative braking system to be reused for lighting and other onboard equipment.

“Fitting everything in within the restricted British loading gauge was always going to be a challenge, but we’ve achieved this by the removing the cumbersome camshaft/resistance
equipment,” Dare says. “Using automotive engines for rail applications has historically been problematic, but our development programme has been very rigorous. There has been lengthy testing of vibration, engine temperature, and wear and we’ve run simulations of duty cycles taken from actual routes in our target markets.”

The trains will have a maximum speed of 100km/h - lower than Pacer and Sprinter DMUs they are intended to replace - but Vivarail argues that the traction package will provide much better performance on regional and suburban services. Performance simulations comparing a three-car D-Train with a three-car Sprinter or Pacer on routes in West Yorkshire have shown typical savings of 20 seconds for each inter-station section.

“The D-Trains have more installed power and lower weight, so the power:weight ratio is much higher than for the existing Pacer and Sprinter units,” explains Dare. “Combined with the performance characteristics designed into the dc chopper equipment, the traction package gives the train a very high rate of acceleration.”

The D-Train will be fitted with a TSI-compliant cab, new gangways, and new signalling equipment for mainline operation. As the District Line shares tracks with Network Rail, the trains were subject to approval by the Rail Safety and Standards Board (RSSB). Vivarail says this means that a significant part of the approval process has already been completed.

Vivarail says lease charges will be “significantly lower” than for existing DMU fleets. “We have assumed a 10-year life for financial purposes,” Dare explains. “This ensures that the D-Trains are viable even on a short franchise. The engineering life will be much longer - the bodyskins are corrosion-free, the bogies are only 10 years old, and virtually everything else will be brand new, so we expect the trains will be fit for at least 25 years’ operation.”

With the Northern franchise coming up for renewal, D-Train is touted as an option to replace the Pacer fleet. The invitation to tender (ITT) specifies the procurement of at least 120 new DMU vehicles to enable Pacer withdrawal. This will not be a direct replacement as the new trains will be used on fast or semi-fast services, releasing Sprinters to enable Pacers to come off-lease.

However, the ITT also calls for increased frequencies on a number of regional and suburban routes and the use of converted metro stock on these routes is not ruled out. Indeed, bidders have been studying the D-Train option closely. “We have had a lot of interest for operations around the major UK provincial cities, and especially for the re-selling of the Northern Rail franchise,” says Dare.

Here the D-Train encounters a political quandary. While significant sums have been ploughed into new rolling stock for southern England in recent years, the north has lagged behind. The idea that northerners should be travelling around in 30-year-old London Underground stock - regardless of the level of modernisation - when billions of pounds have been invested in new trains for the southeast has understandably drawn sharp criticism from the media, unions, and politicians. With a general election looming this month, both secretary of state for transport Mr Patrick McLoughlin and rail minister Mrs Claire Perry have reportedly dismissed any of the D78s in northern England, even though the Northern franchise ITT appears to support the concept.

The challenge for Vivarail is therefore to convince its critics that the D-Train concept is viable as a low-cost solution to the lack of fleet capacity and ageing rolling stock - a process that will begin in earnest when the demonstrator is unveiled this summer. “Britain has rightly but belatedly embarked upon a large-scale electrification programme, but this will take time,” Dare concludes. “D-Trains enable services to be improved now, with electrification to follow. The high cost of investing in conventional new DMUs would effectively freeze out electrification for a generation.” IRJ

**D-Train suppliers**

**Revolve Technologies:** power rafts and alternators, and engine control systems  
**Motorail UK:** Secure storage, engineering workshops and test track  
**Phenolics:** toilets and passenger information systems  
**Creative Design:** industrial design, cab structure re-engineering and train interiors  
**Carriage:** seating fabrics  
**BMAC:** headlights and marker lights

The D-Train will be fitted with a new TSI-compliant crash-resistant cab.